NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE SPECIFICATION

SALINITY AND SODIC SOIL MANAGEMENT

CODE **610**

1. Soil Testing

Determine degree of salinity and/or alkalinity by laboratory analysis, including tests made by NRCS soil scientists, whenever plant growth is adversely affected or if soil salinity or alkalinity is a question.

2. Plant Salt Tolerance

Use plant adapted to the expected maximum of harmful salt concentration as shown in **Table 1**.

3. Saline and Alkali Soils

When soil salinity exceeds tolerances shown in **Table 1**, toxic salt reduction will be needed.

a. Saline conditions. ECe x 10^3 is in excess of four mmhos/cm at 25 degrees C. Exchangeable sodium percentage is less than 15. Ordinarily the pH is less than 8.5.

a. Treatment is as follows:

- Apply leaching with adequate drainage.
- Do not use clean fallow on these soils.

b. Alkali conditions. ECe x 10^3 is less than four mmhos/cm at 25 degrees C. Exchangeable sodium percentage is greater than 15. Ordinarily the pH readings are greater than 8.5. Treatment is as follows:

- Apply chemical amendments to reduce the percentage of exchangeable sodium and to flocculate the soil.
- Use leaching with adequate drainage in conjunction with added soil amendments as follows:

1. Apply dry amendments by thoroughly mixing them in the soil with a disc.
2. On areas where there is an alkali zone or layer in the subsoil, deep placement of chemical amendments by chiseling or plowing may be used.
3. Follow application of chemical amendments, except for sulfur, by immediate leaching. Depending upon conditions, sulfur needs to be left on the soil for two to three months before it will dissolve. Soil moisture needs to be maintained at least 50 percent field capacity during period of sulfur breakdown. It is desirable to follow leaching with application of mulches (see standard and specification for mulching) and/or seeding of close spaced fibrous rooted soil-improving crops or grassed such as barley, tall wheatgrass or alfalfa.
4. Following initial application of amendments, it is desirable to apply 200 pounds of gypsum or equivalent amounts of other amendments per acre annually, or 400 pounds per acre every two years.

c. Saline-Alkali conditions. ECe x 10^3 is in excess of 5 mmhos/cm at 25 degrees C., and the exchangeable sodium percentage is greater than 15 with excess salt condition pH higher than 8.5. Treatment is as follows:

- Apply as shown in paragraphs a (saline) and b (alkali) concurrently. Alkali treatment should be applied in conjunction with saline treatment in order to prevent soil dispersion which will occur if saline treatment alone is applied.

Table 1

Relative Tolerance of Crop Plants to Salt, ECe x 10^3 1/

Field Crops	Forage Crops	Vegetables & Fruit Crops
	Good Tolerance	
16	**18**	**12**
Barley (grain)	Alkali sacaton	Garden Beets
Sugar Beets	Bermuda grass	Asparagus
Cotton	Rescuegrass	Spinach
	Canada wild rye	
	Tall wheatgrass	
	Western wheatgrass	
	Barley (hay)	
	Birdsfoot trefoil	
10	**12**	**10**
	Moderate Tolerance	
10	**12**	**10**
Rye (grain)	Sweetclover (white & yellow)	Tomatoes
Wheat (grain)	Perennial ryegrass	Cabbage
Oats (grain)	Mountain brome	Grapes
Sorghum (grain)	Strawberry clover	Cantaloupe
Corn (field)	Sudan grass	Bell Peppers & Chili
Castor beans	Hubam clover	Cauliflower
	Alfalfa	Lettuce
	Tall fescue	Sweet Corn
	Rye (hay)	Potatoes (White Rose)
	Wheat (hay)	Carrots
	Oat (hay)	Onions
	Orchardgrass	Peas
	Meadow fescue	Squash
	Reed canary	Cucumbers
	Smooth brome	
	Tall meadow oatgrass	
6	**4**	**4**
	Poor Tolerance	
4	**4**	**4**
Beans, field	White dutchclover	Radishes
	Meadow foxtail	Green Beans
	Alsike clover	Pecans
	Red clover	Fruit Trees
	Ladino clover	Strawberries
	2	**2**

1/ The numbers following ECe x 10^3 are the electrical conductivity values of the saturation extract in millimhos per centimeter at 25 degrees C. associated with **50 percent** decrease in yield. Range of tolerance is shown within each column. Example: Field crops--moderate tolerance--range from ECe x10^3 = 10 (shown at top of column) for rye, grain to ECe x 10^3 = 6 (shown at bottom of column) for castor beans.

Table 2
Tons of Amendment Per Acre Foot of Soil

Exchangeable Sodium (Meq. Per 100 gm of soil) to be replaced	Gypsum	Sulfur	Sulfuric Acid
1	1.7	.32	.98
2	3.4	.64	1.96
3	5.2	.96	2.94
4	6.9	1.28	3.92
5	8.6	1.60	4.90
6	10.3	1.92	5.88
7	12.0	2.24	6.86
8	13.7	2.56	7.84
9	15.5	2.88	8.82
10	17.2	3.20	9.80

Example on use of Table 2:

The laboratory data shows that the surface foot of soil contains 5.0 milliequivalents (Meq) of exchangeable sodium (Na) per 100 grams (gr) of soil and has a cation exchange capacity of 20 milliequivalents per 100 grams of soil.

Problem: How many tons of gypsum per acre will be needed to reduce the exchangeable sodium percentage (ESP) to ten percent in the top foot?

Step 1 $ESP = \frac{\text{meq. exch. Na/100 gr. soil}}{\text{cation exch. capacity of soil}} \times 100$

$ESP = \frac{5}{20} \times 100 = 25\%$

Step 2 To determine how many meq of exch. sodium per 100 gr of soil is to be replaced by calcium (from gypsum), keeping in mind that we wish to reduce the ESP to ten percent of its present value, divide as follows:

$\frac{\text{10 (ESP to be reduced to)}}{\text{25 (ESP present value)}} \times 100 = 40\%$

40% is the percent exchangeable sodium that will still remain after treatment.

Step 3 Detemine percent of exchangeable sodium to be replaced.

100% - 40% = 60% of exchangeable sodium to be replaced.

Step 4 Determine the meq. of sodium to be replaced per 100 grams of soil. Sixty percent of 5 meq. exch. Na. = .60 x 5 = 3 meq. Na to be replaced per 100 grams of soil.

Step 5 Refer to **Table 2** to find that 5.2 tons of gypsum will be needed, or

Step 6 Refer to **Table 4,** to determine quantity of gypsum to apply in order to reduce ESP to 10%.

4. Leaching

a. Leaching will be done in accordance with procedures adapted for the area.

b. When lands are devoted to annual crops, primary leaching will be done at a time when the land is not occupied by a crop. Supplemental leaching, if needed, may be done during the growing season with regular irrigations.

c. When lands are devoted to perennial crops, primary leaching will be done prior to establishment of the crop.

If leaching is needed after establishment, the depth of water cover will not exceed 18 inches (There is no assurance that damage to plants and stands will not result.).

Use **Table 3** for inundation tolerance of selected species.

5. Supplemental Treatment.

a. Control harmful salt accumulation in immediate vicinity of seedlings.

(1) Use peaked beds or lister beds which will permit seeding to be performed on the side of the bed or in the furrow so as to pull salt away from seed or vegetative part of plant.

Table 3

Inundation Tolerance in Days by Stage of Growth [1/]

	Semi-dormant	Plants growing Profusely with slight development of stolon and stems prior to flowering	Advanced profuse growth of stolons and stems and many seed heads
Bermudagrass	20	20	20
Buffalograss	20	10	5
Vine mesquite	20	20	20
Switchgrass	20	15	10
Sand bluestem	10	5	2
Alkali sacaton	20	15	10
KR bluestem	10	5	2
Weeping lovegrass	10	2	2

[1/] Top growth may be severely killed back during active growing periods.

b. Fertility

(1) Leaching to remove excess salts also removes soluble plant nutrients; therefore, periodic applications of fertilizers and manure are necessary for good crop production. Fertilizers should be applied after primary leaching. Fertilizer amounts should be consistent with needs but should be applied in smaller amounts and more frequent applications.

(2) Use fertilizers that do not contribute to the accumulation of harmful salts such as those containing sodium.

For Example: Do not use sodium nitrate; instead, use ammonium nitrate or urea.

c. On soils where irrigation water or soil properties are conditions which make reduction of toxic salt difficult, (1) return large quantities of organic materials to the soil; and (2) use highly intensive program of soil-protecting high residue crops and/or perennial hay – pasture crops that are salt tolerant. Keep ground covered as much as possible.

d. On cropland soils where the conditions (soil, irrigation water, water table, etc.) will not permit reduction of harmful salts to acceptable levels, consider alternative land use.

Table 4

Quantity of Gypsum Necessary to Reduce ESP to 10% (Tons / Acre Foot)					
CEC \ ESP	15	20	25	30	35
5	0.4	0.9	1.3	1.8	2.2
10	0.9	1.7	2.6	3.5	4.3
15	1.3	2.6	4.0	5.3	6.6
20	1.7	3.4	5.2	6.9	8.6
25	2.1	4.3	6.5	8.6	10.8
30	2.5	5.1	7.7	10.2	12.8